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ABSTRACT

A study was conducted in 1986 which revealed that school-based computer coordinators used a combination of product- and client-centered strategies to facilitate computer use, but saw their role as transitional, predicting elimination of their jobs in 2 to 5 years. The purpose of this current study was to revisit the three schools (Eugene, Oregon) studied in 1986 in order to examine the work of the technology coordinators and the outcomes that they were able to effect over the past 7 years. A case study design was employed in the research, which used questionnaires, interviews, observations, and a review of relevant planning documents to examine the work of the coordinators. The following questions are answered: (1) What is the situational and historical context in which the technology coordinators have done their work? What conditions exist today? What has changed?; (2) What outcomes were the technology coordinators able to effect over the 7-year period?; (3) What are the impediments to the integration of technology in schools?; and (4) What strategies are used by the coordinators and teachers to overcome impediments to technology use in their schools? The present study supports the effectiveness of staffing change agents to work with teachers at the school level. Three tables illustrate research findings. (Contains 16 references.) (MAS)

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THE ROLE OF SCHOOL-BASED TECHNOLOGY COORDINATORS AS CHANGE AGENTS IN ELEMENTARY SCHOOL PROGRAMS: A FOLLOW-UP STUDY

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While much has been written about the potential of computers to enhance teaching and learning, the current literature suggests that K-12 schools are relatively unaffected by new information technologies (Cuban, 1993; Papert, 1993). Commonly cited reasons include inadequate computer resources, lack of teacher preparation, lack of planning time, and lack of on-site support (Sheingold & Hadley, 1990; Strudler & Gall, 1988; U.S. Congress, 1988). One approach to addressing such obstacles has been to employ computer coordinators at the school and district levels. A series of national surveys (Barbour, 1986; Bruder, 1990; McGinty, 1987) have documented the growth and challenges of this new role.

One study (Strudler & Gall, 1988) conducted in 1986, conceptualized computer coordinators as change agents and analyzed their strategies, skills, and achieved outcomes. The three case studies revealed that school-based computer coordinators use a combination of product- and client-centered strategies to facilitate computer use. These strategies include training of teachers, providing technical assistance, organizing the school's instructional computing program, and supporting and energizing teachers. Outcomes effected by the computer coordinators include improved teacher skills and readiness for further growth, implementation of school goals, teacher satisfaction with the program and increased feelings of self-esteem and professional growth, and greater student comfort with computers. Interestingly, the coordinators in that study all saw their role as transitional and expected to "work themselves out of their jobs" within two to five years.

The purpose of the present study was to revisit those same three schools to examine the work of the technology coordinators and the outcomes that they were able to effect over the past seven years. Specifically, it set out to answer the following questions:

1. What is the situational and historical context in which the technology coordinators have done their work? What conditions exist today? What has changed?
2. What outcomes were the technology coordinators able to effect over the seven-year period?
3. What are the impediments to the integration of technology in the schools?
4. What strategies are used by the technology coordinators and teachers to overcome impediments to technology use at their schools?

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Method

Research Design

This study employed a case study design (Yin, 1989) that used questionnaires, interviews, observations, and the review of relevant planning documents to examine the work of three computer coordinators and the implementation of computers at their schools. Multiple sources of data were used allowing for validity checks on the context, reported strategies, and achieved outcomes.

Sample

The present study was conducted in the same three elementary schools in Eugene, Oregon that were examined during the initial study. In 1986 a sample of three schools was selected because their coordinators had been identified as having brought about a high degree of implementation of educational computing. At that time, Eugene School District 4J had nine released-time computer coordinators at the elementary level (defined as being allocated a minimum of a half-day a week to perform their role). The identification process involved consulting with the district computer coordinator, the district evaluation specialist, and the Educational Service District curriculum/staff development specialist, and by personal observation of computer implementation in the schools.

In May 1993, all three teachers who were primarily responsible for coordination of their computer programs since 1986 were still working at their respective schools. Two of them (designated as Tom at East School and Sue at Central School in this report) were subjects in the initial study and remain the "driving forces" in their current programs. A third teacher (Judy at West School), though primarily responsible for coordination of computers at her school over the years, was not a subject in the initial study because she served as a teacher on special assignment (TOSA) for computers at the district level that year rather than working as a West's computer coordinator. Judy was, however, interviewed (considered as a supervisor) in the initial study. Further details that clarify staffing choices made at the respective schools can be found in the description of the situational and historical context in the Results section of this paper.

Data Collection Instruments

Interviews and a questionnaire were adapted from those used in the studies of school improvement coordinators (Miles, Saxl & Lieberman, 1988), staff development specialists (Beaton,1985), and computer coordinators (Strudler & Gall, 1988). A form of the questionnaire was given to each coordinator to assess his or her priorities, strategies, and

achieved outcomes. Another questionnaire, almost identical, asked supervisors and teachers to prepare a similar profile for each coordinator.

Semi-structured interview schedules pertaining to the role and qualities of the coordinators were administered. Informants included the coordinators, their supervisors (current principals, past principals, and district computer coordinator), and their clients (the teachers in their schools). Thirty-eight informants participated in a total of 42 interviews (the three school coordinators and the district coordinator were interviewed twice) ranging from twenty-five minutes to two hours in length. Further data were gathered by direct observation and analysis of planning documents. The data were collected over a three-week period. A summary of the informants in the sample by school and type appears below in Table 1.

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Data Analysis

All 42 interviews were tape recorded and transcribed. Employing the constant comparative method (Strauss, 1987), data analysis began as data were first collected and continued throughout the study. A coding framework for four main categories (school context, outcomes, effective change agent behaviors/strategies, and impediments) and 26 sub-categories, was initially adapted from Miles and his colleagues (1988) and Strudler and Gall (1988) and was further revised as additional themes emerged. Interview data were coded and more than 800 illustrative segments, ranging in length from one sentence to two paragraphs, were copied from word processor files to database records using the macro capabilities of the ClarisWorks (1993) integrated package.

Analysis proceeded with grouping of similarly coded items (e.g., context or outcomes for a particular program or strategies for a particular coordinator) using the *Find* function of the database module. Field notes and interview data were thus analyzed in a thorough and systematic fashion, searching for salient themes pertaining to the work of the coordinators and the efforts of teachers to implement technology in their schools. The data were analyzed case by case, and then across cases. To ensure the accuracy of the reporting, drafts of each case were examined by the respective coordinators, principals, and the district coordinator, and corrections were made where necessary.

Results

The results of the study were organized to answer each of the four research questions. The context (Question 1), followed by outcomes (Question 2) are reported together, case by case, to give the reader a flavor for each school as a unique case. The impediments to the

integration of technology (Question 3) and strategies used to overcome them (Question 4) are then reported across cases to allow for a broader analysis of results across school sites.

1. What is the situational and historical context in which the technology coordinators have done their work? 2. What outcomes were the technology coordinators able to effect over the seven-year period?

District Context

The study was conducted in the Eugene Public Schools, a medium-sized district of more than 1200 teachers and approximately 18,500 students (K-12). The district is home of the University of Oregon and shares with two other local districts the provision of education to a northwestern regional center of 165,000 people. The district serves about 8500 elementary school children in its 24 elementary schools. By Spring 1993, there were approximately 1250 computers used in K-5 programs.

Under the leadership of John, the district technology coordinator, a number of elementary schools in the district were "early adopters" of educational computing. In 1984, a systematic, district-wide approach to integrating computer-based tools (graphics, keyboarding, word processing, and problem solving) was planned to be phased in over a three-year period. The district provided software and training as an incentive for schools to participate voluntarily. The three schools examined in this study participated in the initial efforts to implement the plan.

The program was piloted and deemed by evaluators to be feasible, contingent upon continued district support for computer resources and staff development (Ames, Gilberstadt, Sky & Strudler, 1985). It was recommended that part-time "computer persons" be designated to coordinate training, maintenance, and scheduling at the school level. Without such services, the evaluators concluded that implementation of the program would be difficult.

During the 1984-85 school year, only one of Eugene's 24 elementary schools (East School) employed a released-time computer coordinator (defined as a teacher who is assigned .10 FTE or greater for coordinating elements of the computer program in the school). By the following school year, nine elementary schools had opted for released coordinators. Under the district's ongoing policy of site-based management, the decision to employ a computer coordinator is made at the school level. Each school is allocated a specified full time equivalent (FTE) for hiring teachers, including specialists (media, physical education, music, art, etc.), based on the school's enrollment. From the allotted FTE, building principals, often with the input of the staff, may provide for a released-time computer coordinator.

Severe budget cuts in the years following the initial study posed serious threats to the growth of efforts to integrate computers into Eugene's elementary schools . Adequate monies were not allocated to support the implementation of the district plan and the three-year timeline was abandoned. Furthermore, resources to staff released-time coordinators became increasingly sparse due to Oregon Ballot Measure 5 which significantly reduced property tax revenues. This led to massive budget cuts in Oregon's public schools and necessitated reductions in new hires, cuts in the staffing of specialists, and increases in class size. By 1992-93, only one of Eugene's elementary schools (Central School) was able to staff a released time technology coordinator. See Table 2 for a summary of the FTE allocated for released coordinators at the three sample schools since the 1984-85 school year.

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East School

Context. East School has 411 students and 26 full-time and part-time teachers. It serves a community of middle to upper middle income families in the rolling hills along the outskirts of Eugene. The school is divided into 5 quads, each of which share a common building and a "mini-school" identity. One of the quads has formally obtained the designation as an alternative school, one of several alternative elementary programs in Eugene. The alternative quad maintains a distinct identity apart from the overall school program, but participates in many school-wide endeavors including the computer program.

East's faculty characterize the "flavor" of their school as innovative, challenging, diverse, and child-oriented. One teacher explained, "I feel real good about the program. It's evolving, it's changing, it's challenging, it's difficult, it's the hardest thing I've ever done in my life, [but] I've never gotten bored with it."

In 1986, the two main goals of the computer program at East were to get students using computers in their studies and to train the classroom teachers so that they would become comfortable incorporating computers into their instructional program. Thus, Tom, the coordinator, was hired to organize the program, teach the students, and teach the teachers. One teacher described how the program functioned:

> Tom taught computers to students, he also ran workshop for teachers and when some new program would come in, would call us in after school or before school, or whenever we have breaks, to introduce us to the materials. We were free to take our kids in there when the computer lab was not being used for instruction, or we could arrange special things if there was something that we wanted done.

Originally, East's goal was to have a computer person and a computer lab for only one or two years. The East computer plan of May 1986, however, stated that the computer room should remain for the foreseeable future, space permitting. The status of the lab, as well as the coordinator position, was reassessed annually. In 1991, the coordinator's FTE was cut to .1 and subsequently eliminated entirely due to budget constraints. The lab continued to function until the beginning of the 1992-93 school year when it was dismantled to accommodate the need for an additional classroom. Computers were then distributed into the classrooms or "pooled" into small groups in the quad areas.

Outcomes. Informants at East School were uniform in their praise for Tom's work and the outcomes that he was able to effect as East's technology coordinator. As was reported in the initial study, Tom continued to manage the many details of computing at East while supporting the faculty's efforts to teach with technology. One teacher characterized Tom's style:

> He's very supportive, very service-oriented--anything you want. Very creative. "Have you tried this, have you thought about that?" Very encouraging, I think. He tries to help people get as far as they could, but he wasn't going to steam roll anybody or push anybody.

Another teacher added,

> Oh I think he's a really good teacher. He doesn't take over, he lets you kind of learn as you go. And if he doesn't know it, he finds out for you at some point. And he is so easy going about things. He's not this uptight, fast moving person--he's wonderful. I just have a high regard for him.

Commonly cited results of Tom's work include the use of new instructional materials and the improved skills of both students and teachers. Tom's own assessment of the teachers' progress with computers is strongly supported by teachers' comments:

> I think they feel a sense of independence that they didn't have before with technology. They were willing to surprise themselves. They're not afraid of punching the wrong the key and exploding the computer. They're not as tentative as they used to be. The way I see that is when somebody new comes into the building and I see how tentative they are, I realize that the other people have come a long way.

The East faculty, however, expressed dissatisfaction with the loss of their coordinator and their lab. While they accepted that staffing a coordinator was impossible under the wave of budget cuts, many favored reinstituting the lab. In fact, at a faculty meeting at the end of the

1992-93 school year, all teachers, except for Tom, wanted the lab back. As a result of Tom's organization and modeling in the lab, teachers got comfortable using computers in that setting. According to East's faculty, the model worked. They learned in a comfortable, supported setting, and students had a variety of learning opportunities with technology.

Unfortunately, the East teachers were not prepared for the changes that were to come. While they reported functioning fine with computers during 1989-90 when Tom was on study-leave, they welcomed his return the following year, and in many cases, began to rely on having him back to help. Subsequently, when Tom's position could no longer be funded, teachers reported that some of the responsibilities of the coordinator were distributed among the faculty and the lab functioned adequately for two years--not to the level of organization attained when Tom had time to coordinate it, but to a standard acceptable to most teachers.

In 1992-93, the program went through major upheaval when the lab was dismantled. While many teachers reported an increase in their use of computers for their own productivity, they cited a decrease in the quantity and quality of computer use by their students. One teacher explained, "I think it's been a real detriment to the program not to have a lab because we were going so strong the first two years I was here, and then all of a sudden it pretty much dropped off." Another added, "For me, it hasn't been real successful using them in my classroom Prior to that I loved it. I thought it was grand."

One teacher, who admittedly was one of the few resistant to computer use, commented on the abrupt change, from the lab to the classroom.

> I got totally walked off the cliff when the lab went out. Even when the facilitator was gone, Tom had taught us enough. I know enough programs and I could teach it. And then, when we came down to what we have now [computers in the classroom], it's like I can't get all my kids in at once. So how do I teach them? I just don't know. I don't feel good about that in that I feel that I should be doing more. I feel frustrated because, though I feel like I should do more, in the past we've had somebody to help organize, to help set it up and to give some kind of counseling or guidance or answer questions. I found it real easy, for instance, after Tom left, for the kids to operate a lot of the games that I had because they had the background skills....We had our umbrella, and all of a sudden it was dropped. And we didn't do any preparing for the end of the gravy train, so to speak.

Interestingly Tom had proposed the previous year that some teachers pilot test distributing some of the computers in their classrooms, but stated that "they really didn't want to do it. [One vocal teacher] was the leader in not to do that. He said, 'It's working fine the way it is. If ain't broke don't fix it.'

Despite the abrupt changes, many East teachers are optimistic about having computers in their classrooms. A large majority of them, however, continue to cite the need for help in

learning about new software and technologies, and methods for using them in their classrooms.

West School

Context. West School has 390 students and 25 full-time and part-time teachers. It serves a community of middle income families along the outskirts of Eugene. West's faculty characterize the "flavor" of their school as conservative with a very caring, academic, and achievement-oriented program. Consistent with many of the informants' responses, one veteran teacher described the faculty:

> I think it's a very dedicated and experienced staff. We don't have a lot of young teachers here. Most of the people here have taught for a lot of years. Compared to other schools around the district from what I've heard, I think we're probably considered a conservative school in the sense of not trying as many new curriculum ideas as some of the other schools. I think most of the classrooms here would be considered very structured, very task-oriented instructional groups...trying to match kids to their skill levels.

West's principal added, "The teachers are successful. The community is happy with what they're doing. They can show you test scores which show you how effective they are."

West School acquired its first computers in 1982 when a few teachers expressed an interest. During that year, Judy, then a new second-grade teacher at West, and another teacher, helped stimulate further interest among teachers and parents. Fund-raising activities were organized, and West's computer committee began to meet. In February of 1985, six West teachers became involved in the district's pilot computer curriculum. Again Judy, one of the curriculum writers and trainers for the district, was a major force in making this happen at West. The computer committee continued to function and was responsible for managing the hardware and software, organizing the parent volunteer program, annually reviewing the building plan, and scheduling the lab.

In 1985, the building principal, Glenn, and the West staff recognized a need to hire a released-time coordinator for the growing program. When an extra .2 FTE became available after the beginning of school, a half-time kindergarten teacher was hired for the job. The following year, Judy was allocated released-time to function as the school's coordinator. See Table 2 for a summary of the FTE allocated for the coordinator position at West.

Outcomes. Informants reported on questionnaires that outcomes attributable to the work of computer coordinators include the use of new materials, improved student performance, and improved skills for teachers. Interview data suggest that the computer lab is tightly scheduled and used by a majority of its teachers. Whereas early goals were on the integration of

computer-based tools in the curriculum, teachers now cite that the main goal of the program is for skill reinforcement (i.e., drill and practice). Since no one is now working to expand and maintain the software collection, the teachers have accepted working with the "well established" lab sets of older MECC software. One teacher commented on the preference for drill and practice software at West.

> It seems to me there are a few people who would like to see more tool use--kids doing writing and creating art. But it seems like that's the minority now. Mostly, people seem fairly satisfied using the computer as reinforcement....The time that we can get in [the lab] there right now lends itself to little 20 minute to half-hour blocks where the other kind of activity [tool uses] would take more consecutive days or several during the week.

Another teacher commented,

> It became part of a schedule; it didn't become part of a curriculum. This is a very scheduled school and kids have to be at a certain place at a certain time....The teachers felt that it [drill and practice] was an adequate use of computers in education and they didn't want anything else.

Another stated, "The potential for the computer is unlimited and yet there are so many people in our building that haven't looked beyond the simple drill and practice." West's principal attributed the acceptance of the status quo with computers by teachers to two related factors: the loss of the coordinator position and the lack of a school-wide vision:

> I thought when I first got here, the program worked really well because we had somebody to "bird dog" things, keep things on task and keep things going. As it evolved, I think the program works well for the teachers who make it work but we don't have anyone to go to those teachers and say, "Hey I have this program for your curricular area. Do you want to schedule a time to come into the computer room and use it and work with it?" That component is gone.

Regarding the issue of a lack of vision, West's principal stated,

> The technology committee has come up with a vision statement of where they would like to be. The problem is getting everybody else to share that and agree that that is where we would like to be....They're feeling good with what they're doing right now.

A member of the technology committee concurred with that assessment pertaining to a lack of vision and leadership.

> Our committee was trying to get our school away from the drill and practice kinds of

> things. We were trying to get the school away from just bringing in whole classrooms in there and drilling and practicing towards more of an integration of computers into the curriculum and toward the production and doing creative things. Again, we need someone coordinating that.

There appears to be consensus among West's faculty that a coordinator is still needed to organize and maintain the lab's hardware and software, and to help teachers keep up with new programs, applications, and directions. All interviewed agreed that the program had declined without a coordinator and most predicted that it probably would continue to do so. One teacher explained, "I see things that have gone up and are going down....Until something happens to this budget mess, I see it getting worse." Added another, "We still are better off than we were five years ago but I think again we're leveling off and just need to have another boost." Still another stated,

> I think it's pretty chaotic right now because there really isn't anyone coordinating it like it used to be. There used to be a definite schedule that people signed up for and the coordinator [Judy] would seek people out and ask them how can I help you. So when she was computer coordinator it was working pretty well. Now it doesn't seem to be too organized. Teachers just come in and grab what they need off the shelf.

Judy concurred with this assessment:

> I wouldn't say there's a sudden breakdown. I would just say because of the lack of support it hasn't improved as it should have. It hasn't advanced. People who know what they're doing and like it are still doing it, but they're not advancing.

One teacher, who served as coordinator for one year, reported plans to obtain a computer-based publishing center for the 1994 school year. While she believes that this is a step in the right direction, she believes it will take much effort to bring a majority of the faculty "on board." She commented, "I'm afraid that unless someone comes in here who's really a real motivator, [significant change won't occur]". Recognizing the enormity of that task, she added, "That's not me; I'm not going to be the one to do that."

Central School

Context. Central School has 362 students and 22 full-time and part-time teachers. It serves one of Eugene's lower socioeconomic communities along the outskirts of the city. Teachers interviewed at Central characterized the "flavor" of their school as challenging, dedicated, child-centered, diverse, and collaborative yet divisive. One teacher described,

> It's a very child-centered, caring, somewhat discipline-based program in that it is a school that teachers have to have discipline to be able to get anything going. They are very caring, there's a lot of closeness to the child, a lot of concern for kids. Also one where we spend an awful lot of time dealing with non-academic subjects. We have a lot of kids who are really at risk.

In 1983 Central bought two Apple systems. Subsequently the school sponsored a triathalon and other fund-raising events to increase the school's computer resources. All informants agreed that Sue was the driving force that fueled the growth of Central's computer program. Eventually, Sue was given a half-time appointment for the 1985-86 school year and proceeded to organize Central's expanding computer lab. Sue continued conducting inservices for teachers and parent volunteers, activities that she had previously undertaken as the *defacto* coordinator. In December of that year, she submitted a proposal with John, the district coordinator, to Sunburst Communications, a leading publisher of educational software. She proposed that Central School and Sunburst form a partnership in which, together, they would develop a "national model showing 'real life' classroom use and integration of computers" into the math, language arts, and problem solving curricula. Sunburst accepted the proposal, and the Central faculty reaped the benefits of large quantities of software and teacher inservices provided by Sunburst staff. The "Sunburst connection" clearly boosted the teachers' enthusiasm about instructional computer use at Central School. That relationship with Sunburst (and later Wings) continued over the years. In May 1993, Central School had a lab of 25 computers as well as a computer in every classroom.

Outcomes. Central School, which maintained its staffing of a released coordinator (.35 full time equivalent in 1992-93, .3 in 1993-94), appears to be thriving with computer use well woven into the fabric of the school. In many respects, what is occurring at Central could be viewed as a realization of the vision of its computer coordinator. Early on in the program, the coordinator asserted that computers should be integrated into all subject areas and that she would help teachers to do that as an "on-site staff developer," not a computer teacher. While she still models lessons using new programs with students, the teachers accompany their students into the lab and follow up her lessons in their scheduled lab times when the coordinator is not available. In addition, all teachers have at least one computer in their room to further enhance their curriculum. Computer use covers a wide range of applications including skill reinforcement, problem solving, and a variety of tool uses.

Informants cited the improved skills of teachers and readiness for further growth as the most prominent outcome of Sue's work as coordinator. One teacher stated, "Sue spends a great deal of time helping us know how to do the programs she obtains for us and as she does that, we

grow. We become more comfortable in how to do it."

Teachers growing comfort with computers appears to have significantly reduced their resistance to technology integration. As explained by Central's former principal, the initial resistance was not "in the sense they didn't want to do it, but resistance in the sense, 'I don't think I can do it.' Sue was very successful in getting people on board and on track with that."

One teacher recalled when she began teaching at Central in 1988:

> The computers were well established as part of the curriculum and there was a tremendous effort to bring teachers up to date technologically. Several of us were computer illiterate and didn't see a place for them in the classroom. We sort of had to be dragged kicking and screaming into the 21st century....[But] there was a lot of support. There was a half-day training available. There was computer assistance when I brought my children into the computer lab and after school in-services, and it was incredibly remarkable, the kind of support given to the program and the energy and attention. It was just so necessary to make all of this happen.

In May 1993, resistance at Central appears to be almost non-existent. One teacher assessed, "Everybody wants to be down in the lab. Everybody would love to have more computers in the room." Another stated, "There isn't anybody who isn't really involved with it." Still another added, "Sue saw the staff when we were so reluctant, and she said that we'd all be using these and we'd all feel more comfortable, and you'll want more. She was right."

Sue characterized the progress of Central's faculty as a "picture of steady growth" as resources and comfort levels have increased. In spite of this progress, however, Sue admits to "backing off" of her earlier efforts to have the teachers gradually assume more responsibility for introducing programs to their students. While this stance runs counter to her goal of "working herself out of a job," Sue's appears to accept the compromise of that position:

> Teachers said, "It would be so much easier for us, if we saw you on a regularly scheduled basis, presenting a lesson and showing us how you manage the class, manage the lab, manage the software, and then plan with us as you've always done. But instead you provide the role model." They didn't want it to be so they could send their class to me and then they go away. Teachers still come. When they come to the lab and I am teaching they are still there. They stay and take notes for the most part and are ready to follow up on what's happening or go in another direction that they want to go, depending on the decisions that we've made as a team. It really was a request on their part that I teach more, if possible.

One teacher explains how he benefits from Sue's approach:

> Where Sue does a lot for me, in this building, is one of my computer periods she helps introduce new material. It's a weak link with me. I've had all of these great intentions

> of previewing and reworking all of these programs and I haven't done it. It's real hard. Sometimes I'm just staying a step ahead of the kids when I'm introducing new material, or I get stuck with things that I can't problem solve.

That same teacher, however, suggested that Sue's strategies in working with him were helping him become a more independent computer user. He explained, "She can push you off the dock when she needs to. She can hold your hand when she needs to and she's usually pretty good at assessing [which approach to use]."

Informants at Central cited improvement in student achievement and attitudes as another major outcome of Sue's work. One teacher stated, "They're [students at Central] so computer literate and I'm always really impressed. When I have a student who transfers in from a different school, I really notice a big gap." Another added, " I think the confidence level [with computers] of the students, and their competency, has definitely increased. I'm always really amazed and excited about the skill level that our students leave here with." Another concurred,

> None of these students have any fear of technology and I'm glad to see that with girls. I think there's a confidence that's there that will stay there that is firmly implanted in their background...I think we send children on who view a computer as one of the necessary tools of school and they're all pretty comfortable in using it in a variety of ways.

Success with technology appears to have elevated the collective self esteem at Central for both students and teachers. Sue stated, "There's a tremendous amount of pride about what we have accomplished and what we have and we tend to hold that up." Central's former principal added,

> They began to get recognized for doing an exemplary type of program. This is always reinforcing when you put a lot of work into it to be suddenly recognized, nationally and even internationally, as having the program that people wanted to come and see. And I think that because of their hard work, that's why this happened--and Sue's hard work. And I think that they began to say, "Hey, we've got something to offer the world."

Summary of Outcomes

Table 3 provides a summary of outcomes effected by the coordinators that were identified by respondents at each school. Based on a questionnaire by Miles and his colleagues (1988), teachers and supervisors were asked to rate up to six outcomes (from a list of 12) that have been realized due to the work of the coordinator. The value given was derived by weighting informants' responses. Outcomes recorded as most typical (rated first on the questionnaires)

were assigned a point value of 6. Outcomes rated as the second most typical were assigned a value of 5. Outcomes rated third were assigned 4, fourth assigned 3, fifth assigned 2, and sixth assigned 1. Then a percentage was computed by dividing the points assigned to each item by the total points assigned for each school. Thus the highest point total, expressed as a percentage, reflects the outcomes identified by informants as most typical at their school.

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3. What are the impediments to the integration of technology in the schools?

Despite the groundswell of enthusiasm for computer use in schools, there are a number of impediments to integrating this technology into the curriculum. Data across cases suggest that while some of the impediments cited in the initial study have been either eliminated or minimized, many obstacles to increased computer use still remain. In general, there appears to be much less resistance to the *goal* of integration of technology throughout the elementary curriculum. While many informants in the initial study viewed computer use as an "add-on" to the curriculum, teachers in the current study reported an increase in applications that fit with their subject area goals. Furthermore, teachers in the current study were less supportive of the need for a "computer teacher"--a subject area specialist who would "do computers" with their students. Overall, teachers appeared "sold" on the potential of teaching and learning with computers. They still, however, frequently cited problems that must be addressed for this potential to be realized. Following is a discussion of impediments identified in the present study--the lack of: (a) time, (b) professional development, (c) on-site support, and (d) adequate computer resources.

Time

One theme involves the issue of *time*--there never seems to be enough of it. Teachers expressed feeling burdened with their present teaching and planning responsibilities and alluded to the numerous demands of their work day, including their participation in "competing" school improvement programs. While a large majority of those interviewed expressed the desire to do more with computers, they felt that they didn't have enough time to learn, keep up with, and plan the use of new software and new applications. Many teachers at West seemed to have accepted the lack of time as a given and settled for what was familiar and readily available. A number of teachers at East expressed a desire to keep up with new ideas and developments, but

there was only limited evidence that this was happening.

Professional Development

A related obstacle involves the difficulty for teachers to participate in technology-related *professional development.* Whereas in the past inservice training was available to them on-site, often with released time, such opportunities were virtually eliminated due to cuts in staff development monies. The district, however, continued to offer a wide range of sessions after school hours, which met the needs of some teachers. Others, however, were disappointed in the professional development opportunities. Explained one teacher,

> When we had a computer coordinator, all of the training for using the computers was done at the school. The district currently offers really quite good classes, but they're 4:00-7:00 P.M, and that's just suicide time if you have family, or even if you don't. It's just a very difficult time after teaching all day to go do that.

On-site Support

Teachers also cited the need for *on-site support* during the school day. One teacher from East School described her need for help and the accompanying frustrations:

> When Tom was there to be that backbone person for us, we had the support we needed. If something was wrong, we knew that Tom could take care of it. But now we're sort of on our own. I work right next door to Tom and so I still scream when something really is wrong. But I'll sit now with the computer for 45 minutes trying to figure out one little glitch, if something has happened when I'm trying to do something rather than going directly to Tom, because I know Tom has his own classroom. So, by the time I get to him, I'm ready to pull my hair out. And it would be helpful to have someone there that I could go to right away, instead of sitting and fumbling trying to figure out answers. Because usually I try and try and still don't get it working.

Scarcity of Computer Resources

Another problem revolves around the *scarcity of adequate hardware and software.* While this impediment was cited less frequently than in the previous study, it was still a major source of concern, especially at East and West schools. Informants were particularly concerned about upgrading their current computers and obtaining new software. They attributed their lack of resources to the budget cuts at the state level and the lack of support from the district. Explained one teacher,

> The schools that have computers are the ones that have done things like have jogathons or had someone who applied for grants to get them. If you don't have anyone who does that, you don't have it [computers] . There's no mandate to do it. There's no real great encouragement to do it. There's no money to do it.

Trends regarding barriers to computer use cited in this study are consistent with those cited by Sheingold & Hadley (1990) in their survey of accomplished, technology-using teachers. While they reported lack of computer resources as the most prominent obstacle in the accomplished teachers' early efforts, they cited lack of time for learning and planning as the biggest obstacle that the teachers currently face.

4. What strategies are used by the technology coordinators and teachers to overcome impediments to technology use at their schools?

As was documented in the initial study , coordinators perform a variety of functions that help schools to overcome impediments to increased technology use. Time to perform their role, of course, significantly influences the strategies employed. The following strategies, which were prominent in the initial study, are revisited in this section: (a) resource adding, (b) organizing and preparing, (c) training, and (d) collaborative problem solving.

Resource-adding

Resource-adding continues to be necessary to address a major impediment to implementation--insufficient computer resources. This strategy is critical due to the need to supplement district funding for computer hardware and software. Coordinators and teachers pursue this strategy by seeking grants from outside sources and soliciting monies from their school's budget for equipment, software, and staff development. Successful *resource-adding* does a great deal to enhance the program's credibility with teachers. Teachers are clearly more resistant to allocating instructional time to computer-based activities if the quantities of hardware and software are inadequate to meet the needs of their students. Though *resource adding* takes quite a bit of time, it appears critical to keep the momentum of a program going.

Organizing and Preparing

The strategy of *organizing and preparing* is a productive response to the "plight" of elementary teachers who are overloaded with a myriad of teaching and planning responsibilities. Effective coordinators, as time permits, perform a variety of functions that help to overcome this impediment. Coordinators help by: (a) organizing and scheduling labs, (b)screening for software that meets the needs of students and teachers, and (c) assisting with custodial chores, often through a network of student and parent volunteers. Data from the current study suggest that trained students who have demonstrated proficiency in specific skills are increasingly being used to help teachers and their classes with computers. Tom initiated an elaborate

training program in which he assessed students' skills and matched them up with requests for help from teachers. Sue also organized a program of student volunteers--*partners in learning*. Parent volunteers, while also effective, appear to require more time on behalf of a coordinator to train, schedule, and retain. Findings of this study suggest that *organizing and preparing* functions maximize teachers' use of instructional time with computers and decrease their resistance to increased use. The strategy of *organizing and preparing* appears especially critical in schools that use computers in a lab environment.

Training

Training of groups , a prominent strategy in the initial study, was reported to have declined a great deal at the schools examined. This can be attributed to cuts in the budget for staff development and reductions in FTE for coordinators. Data from the current study suggest that on-site inservices are a luxury that the schools in this study could no longer afford. Sue explained, "I've done less big group presentations with the staff because there just isn't time for the meetings, but [I've done] lots of one-on-one kinds of stuff. My in-services are going more to district in-service."

Although none of the programs employed a formal *coaching* component, their training program was based upon having the coordinator available to provide *follow-up support* on an individual basis. This strategy, of course, is severely limited by the loss of FTE for the coordinator role. While Tom continued to help people when the need arose, many teachers resisted seeking his help because they knew he had a full teaching load. Without adequate time, it appears that follow-up support is likely to be *reactive* at best. Only Sue, the remaining released-time coordinator, had time to *proactively* employ effective strategies that support training such as *demonstrating and modeling* and *energizing and motivating the clients*.

Collaborative Problem Solving

Collaborative problem solving is a noteworthy strategy that helps teachers and the coordinator to integrate new technology into the school program. Similar to other change agents (Beaton, 1986; Miles et al., 1988), technology coordinators work collaboratively with individual teachers, grade-level groups, and school computer committees to effect change with technology. Often, the coordinators serve as much needed consultants who "filter" through the volumes of new ideas and applications and help teachers find those that fit their teaching areas and skill levels. This strategy of collaboration appears especially important for establishing teacher ownership of the program. Teachers emphasized that effective coordinators listen to what they have to say and involve them in making decisions about the program. Teachers also

expressed being less resistant to change when they can influence the fit between their other curricular responsibilities and the computer program. This is consistent with the findings of the Rand Study (Berman and McLaughlin, 1978), which suggested that involving teachers facilitates commitment as well as more informed decision-making.

Discussion

This sections consists of a discussion of salient findings of the present study, followed by a description of limitations of the study and suggestions for further research. Emerging themes center on the technology coordinator's role in facilitating change in schools. First, the need for the role of technology coordinator is revisited, followed by a discussion of issues to consider when implementing this role. Finally, the implications of the study for educational policy makers is discussed.

Planned Obsolescence Revisited

During the initial study all of the coordinators projected that they would work themselves out of their jobs in anywhere from two to five years. Implicit in this goal was the idea that as teachers became comfortable with computers and various software programs, they would eventually use them in their teaching and no longer rely upon the help of a coordinator. While this is a laudable goal to work toward, in retrospect, it underestimated the complexity of educational change with technology and the amount of sustained effort that it would require of teachers. Following is discussion of three factors that contributed to the difficulty that coordinators found as they attempted to "work themselves out of their jobs": the rapid pace of technological change as it pertains to schools, the concerns of teachers that appear to affect their adoption of technology-based innovations, and the need for coordinating the "nuts and bolts" of educational computing.

Change With Technology: A Moving Target. One variable that coordinators didn't fully account for in their optimistic projections was the degree to which the field of educational computing and technology is a "moving target"--one that is in a state of constant flux and progress. Computer-based technologies and software applications have undergone a period of unprecedented growth that will likely continue for the foreseeable future. Thus, while it may have been feasible to "train" teachers to use one type of computer and a finite set of software programs, how would teachers then keep up with advancements in the field? Who would help them with the "next" applications--new software programs, multimedia, networks, and telecommunications? Even if teachers developed the expertise to explore these areas, would they have the time to pursue them?

Teacher Concerns: Time, Comfort and Priorities. One principal in this study stated that teachers will always find the time to do things if they make it a high enough priority. While this assertion may not account for the amount of time involved in keeping up with new technologies and applications, it does raise an interesting question. When will technology become a high enough priority for a majority of teachers so that they pursue it as a regular part of their professional responsibilities? Data gathered indicate that we are still in an awkward transition period in which the benefits of teaching and learning with technology do not necessarily outweigh the costs. While teachers are increasingly citing the benefits that students derive from computer use, they must weigh the costs in terms of their time and the difficulties of managing to find appropriate software and then get adequate computer access for their students. It follows that as the quantity and quality of technology-based applications increase in the schools, more teachers will make technology a high priority. Meanwhile, the support provided by an effective coordinator serves to "tip the scales" for teachers weighing the costs and benefits of technology use.

New applications add an extra element to the cost-benefit formula--they often take teachers out of their current "comfort zone" by increasing the time and the potential risks involved in using new methods or materials. In fact, teachers' tendency to seek comfort appears to be one factor affecting the coordinators inability to eliminate the need for their positions. Consider the case at Central. Early on, consistent with her timeline to make herself unnecessary, Sue strongly asserted that she would serve as "on-site staff developer" rather than computer teacher. Her willingness to "push" teachers toward independence, though met with resistance, eventually won teachers' respect and got results. On a case by case basis, Sue would introduce new programs for teachers, but would assess their readiness to "take over" and provide them with the support for them to function independently.

Why then would Sue reverse that position and accept introducing all of the new programs with students rather than continuing to "push" the teachers? Her rationale for that approach was that teachers had lost their time for staff development and they could learn new programs as Sue introduced them to students. All things considered, this makes sense. Nevertheless, it marks a serious compromise to the goal of working to eliminate the coordinator's position. Teachers at Central resisted the discomfort involved in taking the next steps toward being independent of Sue and working toward a transition. Sue explained that the teachers would probably experience a "cold turkey" transition only when they were forced to work without her. Meanwhile, they are comfortable with their role and very satisfied with their current arrangement.

Coordinating the Nuts and Bolts. In addition to the professional functions served by

coordinators in their work work with teachers (e.g., staff development and curriculum consultation), there are numerous custodial details that require coordination (e.g., ordering and maintaining hardware and software, scheduling the lab, troubleshooting). If a coordinator's position is to be phased out, who then would provide for these needs? Teachers at East School reported that, in Tom's absence, they distributed his responsibilities among various teachers and that the lab functioned adequately during that time. On the other hand, teachers at West reported that those functions were never properly provided for upon the elimination of their coordinator role. Unfortunately, this appears to be the case in many schools across the country. Data from this study suggests that the lack of coordination is a major impediment to the effective use of technology in schools.

The Role of the Technology Coordinator: Issues to Consider

Findings of this study suggest that schools should consider staffing technology coordinators where the goal is integration throughout the curriculum. Following is a discussion of issues to consider when implementing that role: (a) time, (b) selection and training, (c) the feasibility of exporting an effective model, and (d) computer placement.

Time. Data from this study suggest that reducing the impediments to the implementation of computers will not likely occur without adequate time for coordinators to perform their role. This involves managing a myriad of details and providing the leadership necessary for teachers to establish a shared vision and school plan. If released time cannot be provided, school districts should consider paying a stipend to coordinators as they typically do for athletic coaches and faculty sponsors at the high school level. While districts may currently reap the benefits of many volunteer hours by dedicated coordinators, it is not realistic to expect these teacher-leaders to sustain their efforts and avoid "burn out" if they are not allocated time and/or remuneration for their work. Perhaps some custodial functions could be coordinated by a clerical person or aide. While this would not address the larger educational issues involved, it would help with some of the "nuts and bolts" requirements that must be addressed.

Selection and Training of Coordinators. Prospective coordinators should possess a good balance of technical, interpersonal, and organizational skills. Such attributes were determined to be important for coordinators in the initial study and appear to hold true for today's coordinator as well. These skills include initiative-taking and tenacity to secure resources and "keep the program going." Another important skill involves facilitating group-functioning and decision-making. In addition, the skill of being able to"wean" teachers of their dependence on the coordinator, was, and remains a critical attribute.

Training for coordinators should be considered to increase their effectiveness. With the

growing number of teachers serving in leadership roles, the professional development needs of teacher-leaders is greater than ever (Fullan, 1991). Studies that have focused on other staff developers (Miles, Saxl, & Lieberman, 1988) support this notion and suggest that professional development opportunities be made available for teacher-leaders charged with facilitating change. While coordinators would benefit from participating in a general forum in which they can share concerns, training sessions for targeted needs would also be helpful. As Miles and his colleagues (1988) recommended for change agents in their study, computer coordinators would benefit from training in organizational change. Such training might involve specific strategies and skills in working with the school as an organization, including strategies for working with computer committees to facilitate long-range planning Other topics for professional development might involve issues and techniques related to current hardware and software.

Exporting an Effective Model. While much can be learned from examining effective strategies used by coordinators in this study, it appears that a successful model for technology implementation (e.g., the one employed at Central) will not be easily exportable as a whole. The process of change with technology is complex and appears very dependent upon the skills and strategies of the coordinator as well as the dynamics of the school context. Some elements of the models examined, however, should clearly be considered by all schools. First, the strategy of establishing a school technology committee appears valuable if the goal is to provide broad input and facilitate technology use school-wide. The committee, then, can provide leadership in getting teachers involved and establishing a long-range plan for technology use.

Also, the model of staffing a coordinator as an on-site staff developer/consultant appears effective, though costly. One possible way to phase out reliance on a coordinator, in the case of inadequate funds, might be to use a "multiplier mode" to spread technology use. This strategy consists of asking teachers to lead workshops, demonstrate their work to others, act as mentors, serve as a cadre, and begin to act like teacher specialists (Miles et al., 1988). While such an approach may not eliminate the need for a coordinator, it may help decrease the FTE needed for the role. In addition, schools should continue to increase their reliance on the growing body of "student experts" for help with technology.

Computer Placement: Lab vs. Classrooms. Informants in the current study cited both pros and cons involved in the placement of computers. Ideally, schools will acquire enough computers to maintain a lab for large group instruction while also distributing additional computers for classroom use. One issue raised in the present study involves the difficulty of maintaining a lab without a coordinator to oversee its use. From a logistical standpoint, schools without coordinators may find that computer resources are are easier to coordinate when they are distributed among the classrooms. It appears that teachers are more likely to take

ownership of "their own" computer. On the other hand, if schools choose to dismantle labs in favor of placement in classrooms, they should provide for a sensible transition which must include staff development that focuses on how to best use one computer in a classroom setting.

Implications for Educational Policy Makers

Technology has great potential to enhance teaching and learning in the coming years. Current literature, however, suggests that K-12 schools are relatively unaffected by new information technologies (Cuban, 1993; Papert, 1993). Consistent with other innovations in schools (Fullan, 1991), one reason for less than optimal results for technology use in schools is that inadequate funds have been allocated for implementation support.

The present study illustrates how difficult it is to effect significant educational change. It involved three schools that have been active in implementing and expanding computer use. While the schools have indeed progressed, this study has documented many impediments to full-scale, sustained integration of technology into elementary school programs. It has also shown, however, that school-based technology coordinators, when allocated time to do their work, provide a variety of functions that help teachers to overcome these impediments. As was concluded in the initial study, it appears that without the implementation support that the coordinators provide, it's unlikely that technology will fulfill its promise to impact teaching and learning in the foreseeable future.

The findings of this study are consistent with the findings of other studies on educational change. The present study supports the effectiveness of staffing change agents to work with teachers at the school level.

Limitations of the Study

One limitation of this study involves the sample chosen. The present study examined technology use in three elementary schools in one district. Therefore the findings are not readily generalizable to other school settings in different locations.

A second limitation involves the method of data collection. Data in the follow-up study were primarily gathered by interviewing teachers, coordinators, and supervisors over a three-week period. While relevant documents were examined and classroom observations were conducted, much of the data was based on informants' perceptions and recollections.

Recommendations for Further Study

Results and limitations of the present study suggest the following directions for further research:

1. The present study yielded rich descriptions of technology use at three elementary schools and

the work of technology coordinators at those schools. Little is known, however, about national trends regarding technology coordinators. A comprehensive survey on the role of technology coordinators would be extremely helpful. Such a survey might address the level of released time, if any, as well as the responsibilities of people working in a coordinating role. It might also address trends in staffing certificated personnel to perform some of the tasks involved in educational computing.

2. The present study suggests that school are more likely to realize the potential of technology in education when there is adequate coordination at the school level. In his correlational study, Becker (in press) found that exemplary computer-using teachers were more likely to be found in schools with adequate resources allocated for staff development and computer coordination. More research needs to be conducted that documents elements of effective programs, including the effectiveness of staffing technology coordinators at the school level.

3. The present study cited problems when technology coordinators were phased out of their role. Are there models where programs flourish without funding for coordination? Can progress be sustained without a coordinator? More research needs to be done to explore if alternative models exist that might provide teachers the support they need to implement technology in schools.

4. The present study suggests that technology coordinators can increase their effectiveness through professional development that focuses on effective strategies for teacher-leaders. Such inservice opportunities should be developed, implemented, and evaluated for their effectiveness.

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Table 1. Informants in the Sample by School and Type

		Schools			
Informants	District	East	West	Central	Total
Supervisors	1	1	2	2	6
School Coordinators		1	1	1	3
Teachers		10	9	10	29
Total	1	12	12	13	38

Table 2. FTE Allocated for Released-time Coordinators in Sample Schools

	Schools		
Year	East	West	Central
84-85	.5	0	0
85-86	.6	.2	.5
86-87	.6	.5	.5
87-88	.6	.5	.6
88-89	.6	.5	.6
89-90	0	.5	.4
90-91	.5	.5	.4
91-92	.1	.3	.4
92-93	0	0	.35
93-94	0	0	.3

Table 3. Outcomes Effected by Coordinators by School

	Schools		
Outcomes	East	West	Central
Use of new materials	14.9	21.5	15.1
Improved skills for teachers; readiness for growth	15.4	14.8	18.8
Improved student performance	8.7	18.5	15.1
Program goals implemented	11.8	13.3	15.1
School climate changed	9.2	7.4	6.4
Client satisfaction with program	5.1	8.1	9.6
Organizational change	7.7	6.7	6.0
Satisfaction in relationships with clients	8.2	4.4	1.4
Energized/motivated clients vs. burnout	4.6	3.0	6.0
Short run successes/decisions	8.7	2.2	2.3
Institutionalization of model	5.6	0.0	4.1
Too soon to identify outcomes	0.0	0.0	0.0
	====	====	====
Total	100	100	100